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(72) KAUFMAN, RALPH, US
(72) HUNZEKER, DARIN, US
(72) CAMARILLO, RICHARD J., US
(71) QUALCOMM INCORPORATED, US

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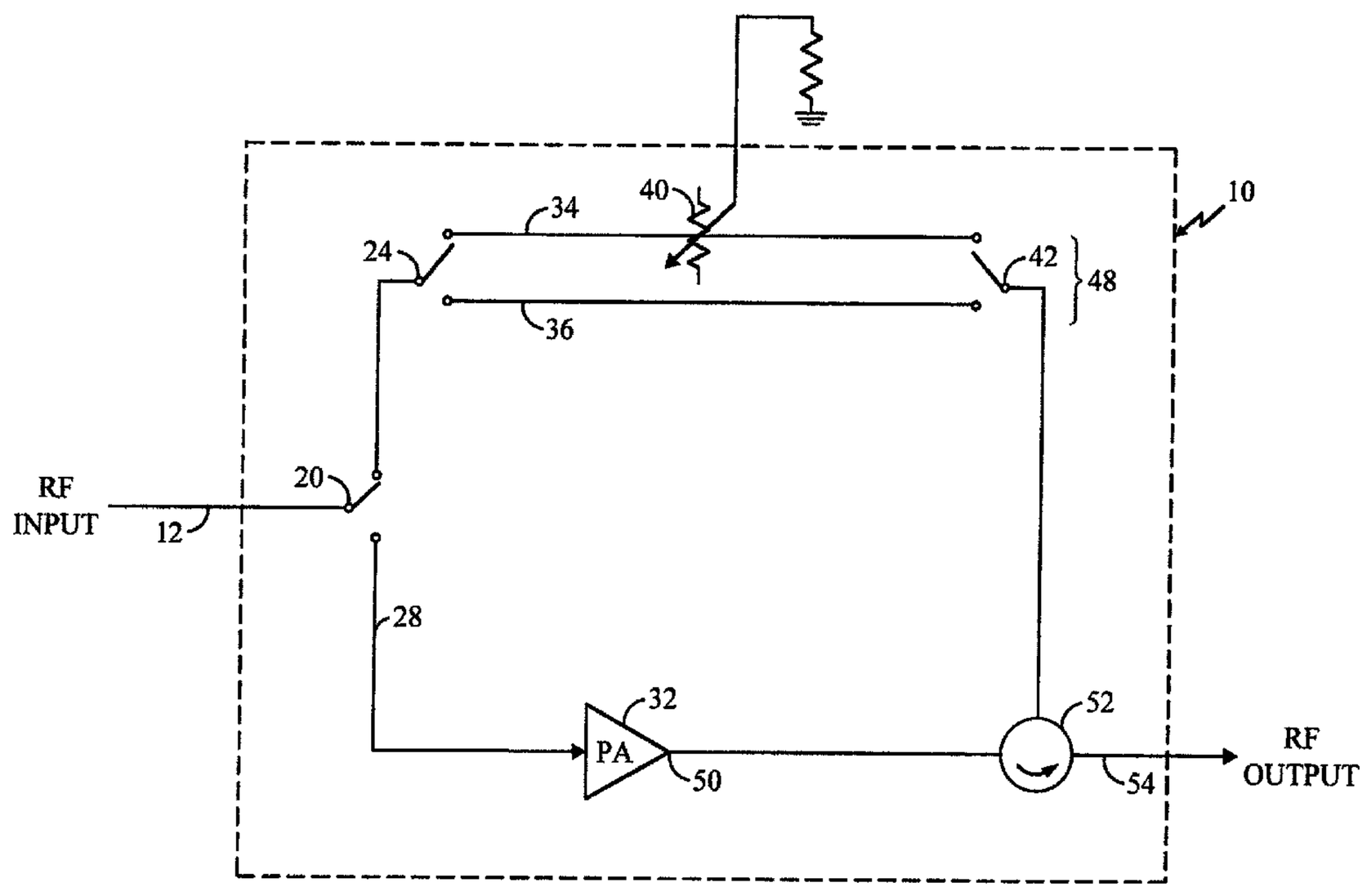
(54) **AMPLIFICATEUR DE PUISSANCE DE GAIN COMMUTE PRESENTANT UNE EFFICACITE ELEVEE**

(54) **HIGH EFFICIENCY SWITCHED GAIN POWER AMPLIFIER**



(57) A power amplifier circuit arrangement including a driver amplifier, a switch, an amplifier path having a band pass filter and a power amplifier, and a bypass path which bypasses the power amplifier when excess gain and output power are not needed. When an RF-analog signal from the driver amplifier is switched to the amplifier path, the signal is band-pass filtered and amplified. Then the signal is split into an in-phase and a quadrature signal. Either the in-phase or the quadrature signal is inverted and summed with the other of the in-phase or quadrature signal, and the summed signal is transmitted to an output port. When the RF-signal from the driver amplified is switched to the bypass path, the power amplifier is turned off and the bypass path directs the signal to the output of the power amplifier, which appears as a high impedance to the signal. The signal reflects off the power amplifier to the output port.

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(71) Applicant: QUALCOMM INCORPORATED [US/US]; 5775 Morehouse Drive, San Diego, CA 92121–1714 (US).

(72) Inventors: KAUFMAN, Ralph; 9307 Laser Lane, La Mesa, CA 91941 (US). HUNZEKER, Darin; 7780 Pipit Place, San Diego, CA 92129 (US). CAMARILLO, Richard, J.; 12626 Via Colmenar, San Diego, CA 92129 (US).

(74) Agents: MILLER, Russell, B. et al.; QUALCOMM Incorporated, 5775 Morehouse Drive, San Diego, CA 92121–1714 (US).

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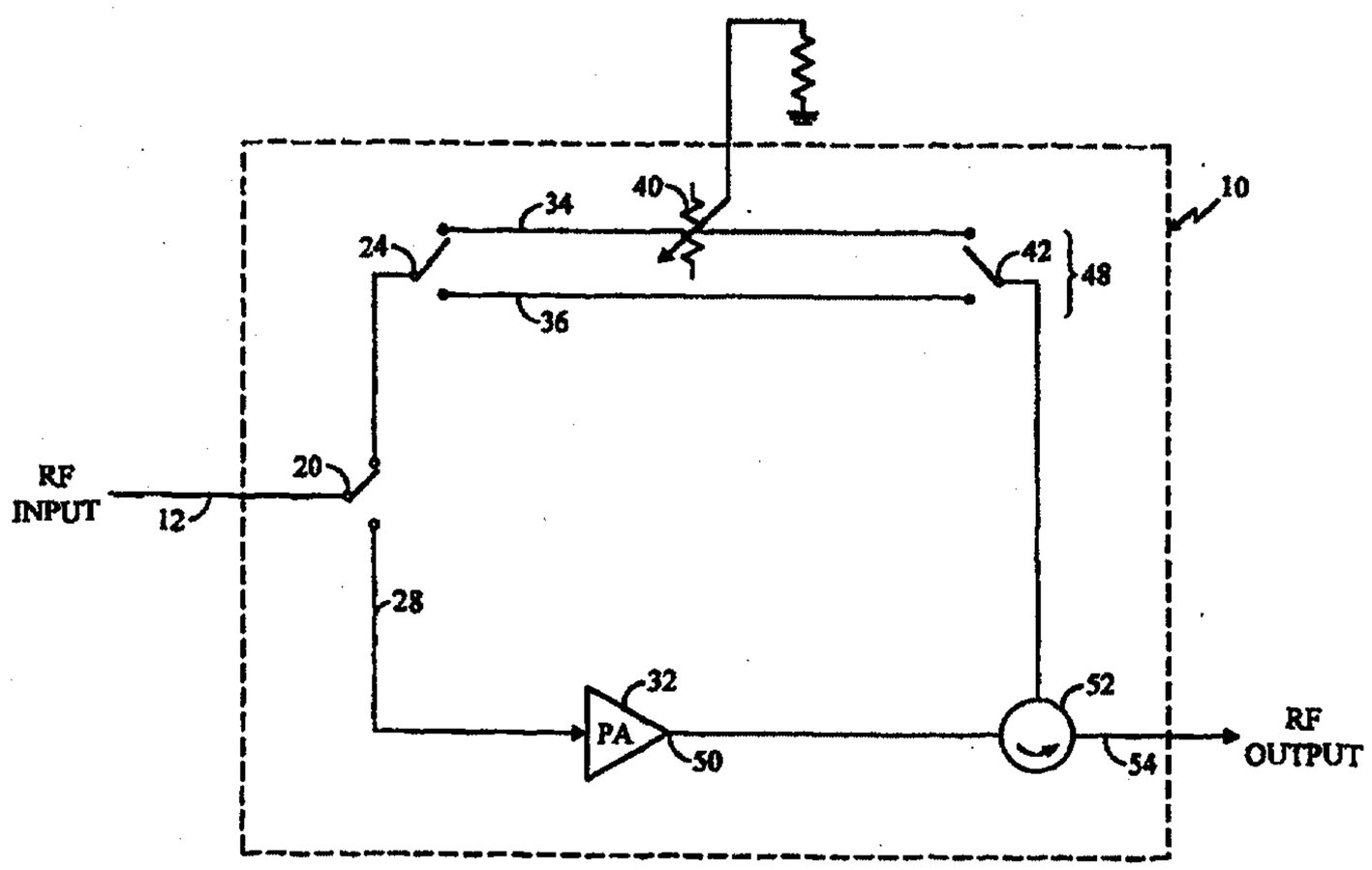


(57) Abstract

A power amplifier circuit arrangement including a driver amplifier, a switch, an amplifier path having a band pass filter and a power amplifier, and a bypass path which bypasses the power amplifier when excess gain and output power are not needed. When an RF–analog signal from the driver amplifier is switched to the amplifier path, the signal is band–pass filtered and amplified. Then the signal is split into an in–phase and a quadrature signal. Either the in–phase or the quadrature signal is inverted and summed with the other of the in–phase or quadrature signal, and the summed signal is transmitted to an output port. When the RF–signal from the driver amplified is switched to the bypass path, the power amplifier is turned off and the bypass path directs the signal to the output of the power amplifier, which appears as a high impedance to the signal. The signal reflects off the power amplifier to the output port.

WO 00/18005 PCT/US99/21758

HIGH EFFICIENCY SWITCHED GAIN POWER AMPLIFIER

BACKGROUND INFORMATION

I. Field of the Invention

The present invention relates generally to power gain control for a power amplifier and particularly to a wireless communication device, such as a CDMA wireless phone.

II. Description of the Related Art

In many electronic environments, such as most hand-held communication systems including code-division-multiple-access (CDMA) or any form of time-division-multiple access (TDMA) technology, RF power output from a mobile unit varies in large dynamic ranges. In a CDMA radiotelephone system, multiple signals are transmitted simultaneously at the same frequency. The signals are spread with different digital codes, thus allowing detection of the desired signal while the unintended signals appear as noise or interference to the receiver. Spread spectrum systems can tolerate some interference, and the interference added by each new mobile station increases the overall interference in each cell site. Each mobile station introduces a unique level of interference, which depends on its received power level at the cell site.

The CDMA system uses power control to minimize mutual interference. A precise power control is critical to avoid excessive transmitter signal power that is responsible for contributing to the overall interference of the system. Power of the individual mobile stations varies with the distance between the mobile station and the base station and the number of other subscriber mobile stations in that base station or sector.

In a typical hand-held wireless unit, the power amplifier is biased class AB to reduce power consumption during periods of low transmit power, but power continues to be consumed. Typically an isolator is used to isolate the power amplifier from the effects of load impedance in subsequent stages. One method to avoid continuous battery draw is to employ a means to bypass the amplifier with switches, and then remove DC power from the Amplifier. This method is illustrated in FIG. 7. A power amplifier circuit **8** is shown with a power amplifier **32** and an isolator **55**. An RF input **12** having an RF-signal to be amplified is connected to a pole of a first switch **20**. When the amplifier is on, the switch **20** connects the RF-input **12**, via path **28**, to an input of power amplifier **32**. The RF-signal is amplified and output to the isolator **55**, and then transmitted through the second switch **42** to the RF-output **54** of the power amplifier circuit **8**. To bypass the power amplifier **32**, the first switch **20** connects the RF-input **12** to the bypass path **30** and the second switch **42** transmits the signal to the RF-output **54**. The drawback of this technique is that the amplifier must overcome the added switching loss during times that higher transmit power is required. This can tend to cancel the benefits of bypassing. Furthermore, using a switch and an isolator requires more power to operate and is more costly to build.

FIG. **6** illustrates a prior art power amplifier circuit. An analog signal is fed from a driver amplifier **280** through a band pass filter **298** to a first switch **20**. The switch **20** alternates between a bypass path **30** and an amplifier path **28**, wherein a power amplifier **32** amplifies the signal. A second switch **42** connects the analog signal from either the bypass path **30** or the output of amplifier **32** to a circulator **55**, which routes the signal to the RF-output port **54**.

SUMMARY OF THE INVENTION

What is needed in the art is a power amplifier circuit which conserves more power and which is less complex and expensive to build by making better use of the isolator, thereby allowing removal of a second switch located after the power amplifier.

An object of the present invention is to increase the efficiency of power amplifier usage by using the termination port of an isolator as the combining mechanism for the bypass network, the power amplifier output, and the RF-output port. With this configuration, an output switch becomes unnecessary.

Another object of the present invention is to provide an improved power amplifier which requires less parts and is less complex to build.

Yet another object of the present invention is to provide an improved power amplifier which is less costly to build.

These objects and others may be realized by the invention disclosed herein. In a power amplifier circuit, a bypass network is provided to bypass the power amplifier in the circuit when the amplifier gain is not required. During these periods of low power operation, the amplifier is turned off. The bypass network consists of a bypass path, and an attenuation path. The attenuation path allows variability through use of an external resistor, and the bypass path allows no variability. Switches operate to control the flow of the signal to the amplifier, or through either the bypass path or the attenuation path. The signal from the bypass network is input to a circulator, which routes the signal to the port connected to the output of the power amplifier. Because the power amplifier is turned off during periods when the bypass is used, it appears to be a very large impedance to the signal. Most of the input power signal is reflected back to the circulator for a normal exit from the RF-out port. An external resistor is used in conjunction with the attenuated path to provide flexibility in the available gain steps.

In another aspect of the present invention, the band pass filter is placed in the amplification path such that filtering is bypassed when the power amplifier is bypassed. This reduces the gain step size when changing modes from amplification to bypass. The driver amplifier therefore becomes the output amplifier and the filter following the amplifier circuitry operates to remove any undesired spurs.

In another aspect of the present invention, when bypassing the power amplifier, it becomes possible to drive the driver amplifier harder and thus provide greater flexibility in choosing gain steps.

BRIEF DESCRIPTION OF THE DRAWINGS

The features and advantages of the present invention will become more apparent from the detailed description set forth below when taken in conjunction with the drawings in which like reference characters correspond throughout and wherein:

FIG. **1** is a plan drawing of the first embodiment of the present invention;

FIG. **2** provides a block diagrammatic representation of a mobile station spread spectrum transmitter in which may be incorporated an efficient power amplifier of the present invention;

FIG. **3** shows an exemplary implementation of an RF transmitter included within the spread spectrum transmitter of FIG. **2**;

FIG. **4** is a plan drawing of a second embodiment of the present invention;

FIG. **5** is a plan drawing of a third embodiment of the present invention;

FIG. **6** is a plan drawing of a prior art amplifier circuit; and

FIG. **7** is a plan drawing of a prior art power amplifier circuit.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** is a schematic diagram showing the broad concept of the invention. A power amplifier circuit, indicated generally by reference numeral **10** comprises a power amplifier **32**, a circulator **52**, a series of switches, **20**, **24** and **42**, and bypass paths **34** and **36** around the power amplifier **32**. An RF-input **12** having an RF-signal to be amplified is connected to a pole of first switch **20**. When the power amplifier is turned on and power amplification is required, the switch **20** connects the RF-input **12**, via a path **28**, to an input of power amplifier **32**. The RF-signal is amplified and output from the power amplifier toward the circulator **52**. The circulator **52** routes the signal to port of the RF-output **54** of power amplifier circuit **10**.

When the power amplifier is not needed and turned off, the switch **20** switches the signal path to a bypass network **48** comprising a bypass path **36** and an attenuated path **34**. To send the signal through the bypass path **36**, switches **24** and **42** switch to a first position such that the signal flows through bypass path **36**. Switches **24** and **42** can also switch the signal to flow through the attenuated path **34**. From switch **42** the signal is transmitted to an input of circulator **52**. The circulator **52** routes the signal to the port connected to the output **50** of the power amplifier **32**. The output of the power amplifier **50** appears as a high impedance to the signal and thus the signal is reflected back to the circulator **52**, which routes the signal to the port of the RF-output **54** of amplifier circuit **10**.

FIG. **2** is a schematic diagram illustrating the use of the power amplifier of the present invention in the signal processing circuitry of a mobile station. In an exemplary CDMA system, orthogonal signaling is employed to provide a suitable ratio of signal to noise on the mobile station-to-base station link, or the "reverse" channel. Data bits **200** consisting of, for example, voice converted to data by a vocoder, are supplied to an encoder **202** where the bits are convolutionally encoded. When the data bit rate is less than the bit processing rate of the encoder

202, code symbol repetition may be used such that the encoder 202 repeats the input data bits 200 in order to create a repetitive data stream at a bit rate which matches the operative rate of the encoder 202. In an exemplary embodiment the encoder 202 receives data bits 200 at a nominal bit rate (R_b) of 11.6 kbits/second, and produced R_b /r = 34.8 symbols/second, where "r" denotes the code rate (e.g. 1/3) of the encoder 202. The encoded data is then provided to block interleaver 204 where it is block interleaved.

With the 64-ary orthogonal modulator 206, the symbols are grouped into characters containing $\log_2 64 = 6$ symbols at a rate of $(1/r)(R_b/\log_2 64) = 5{,}800$ characters/second, with there being 64 possible characters. In a preferred embodiment each character is encoded into a Walsh sequence of length 64. That is, each Walsh sequence includes 64 binary bits or "chips", there being a set of 64 Walsh codes of length 64. The 64 orthogonal codes correspond to Walsh codes from a 64 by 64 Hadamard matrix wherein a Walsh code is a single row or column of the matrix.

The Walsh sequence produced by the modulator 206 is provided to an exclusive-OR combiner 208, where it is then "covered" or multiplied at a combiner with a PN code specific to a particular mobile station. Such a "long" PN code is generated at a rate R_c by a PN long code generator 210 in accordance with a user PN long code mask. In an exemplary embodiment the long code generator 210 operates at an exemplary chip rate, R_c, of 1.2288 Mhz so as to produce four PN chips per Walsh chip. The output of the exclusive -OR combiner 208 is split into identical signals A and B. Signals A and B are input into the exclusive-OR combiners 256 and 254 of FIG. 3 as described below.

FIG. 3 is a schematic diagram showing an exemplary implementation of the RF transmitter 250 in a mobile station. In CDMA spread spectrum applications, a pair of short PN sequences, PN_I and PN_Q, are respectively provided by a PN_I generator 252 and a PN_Q generator 254 to exclusive-OR combiners 256 and 258, along with the output A and B

from exclusive-OR combiner **208** of FIG. **2**. The PN_I and PN_Q sequences relate respectively to in phase (I) and quadrature phase (Q) communication channels, and are generally of a length (32,768 chips) much shorter than the length of each user long PN code. The resulting I-channel code spread sequence **260** and Q-channel code spread sequence **262** are then passed through baseband filters **264** and **266**, respectively.

Digital to Analog (D/A) converters **270** and **272** are provided for converting the digital I-channel and Q-channel information, respectively, into analog form. The analog waveforms produced by D/A converters **270** and **272** are provided with a local oscillator (LO) carrier frequency signals Cos ($2\pi ft$) and Sin ($2\pi ft$), respectively, to mixers **288** and **290** where they are mixed and provided to summer **292**. The quadrature phase carrier signals Sin ($2\pi ft$) and Cos ($2\pi ft$) are provided from suitable frequency sources (not shown). These mixed IF signals are summed in summer **292** and provided to mixer **294**.

Mixer **294** mixes the summed signal with an RF frequency from frequency synthesizer **296** so as to provide frequency upconversion to the RF frequency band. The RF may then be bandpass filtered **298** and provided to an efficient parallel stage RF amplifier **10** of the invention. The filter **298** removes undesired spurs caused from upconversion **296**. A similar filter (not shown) may be located following the amplifier circuitry to remove undesired spurs when the circuit is operating in bypass mode. In a bypass mode, the previous driver amplifier becomes the output amplifier and filtering may be necessary to prevent extra spurs from mixing in the non-linearities of the amplifier. This filtering may be accomplished by the similar filter (not shown), thus the band-pass filter **298** may be located in the amplification path as illustrated in FIGS. **4** and **5** discussed below. This also increases flexibility in choosing gain steps.

FIG. **4** is a second embodiment of the present invention wherein the analog signal is switched 20 between a bypass path **30** and an amplifier path **28**. However, band-pass filtering **298** only occurs in the amplifier

path **28**. Accordingly, the signal is band-pass filtered **298** and fed to the power amplifier **32**, amplified, and transmitted to the circulator **55**, which routes the signal towards the RF-output port **54**. The circulator **55** is connected to ground through a switch **43** and a resistor **45** and the output port **54** of the circuit when the first switch **20** directs the analog signal through the amplifier path. Accordingly, with this configuration, when reflected or returned RF signals enter the circulator **55** from the direction of the RF-output port **54**, the reflected signal is routed by the circulator **55** to ground. When the first switch **20** switches the analog signal to the bypass path **30**, the second switch **43** connects the bypass path **30** to the circulator **55**, and the signal is routed toward the output of the amplifier. This will appear as a high impedance, reflecting the signal back through isolator **55** and to RF-output port **54**.

When high output power is not needed, the power amplifier **32** is turned off and the first switch **20** switches to the bypass path **30**, whereby the power amplifier **32** is bypassed and the driver amplifier **280** operates as the power amplifier. The second switch **43** connects the bypass path **30** to the circulator **55**. The input signal in this mode is routed through the bypass path **30** to the circulator **55**. The signal is routed by the circulator to the output of the power amplifier **32**, and is reflected back through the isolator **55** and to the output of the RF-output port **54**.

FIG. **5** shows a third embodiment of the present invention having a driver amplifier **280** and a band-pass filter **298** for filtering the amplified signal before a first switch **20**. The output from the band pass filter **298** is switched by the first switch **20** which switches between an amplifier path **28** and a bypass path **30**. The power amplifier **32** in the amplifier path amplifies and transmits the signal to a circulator **55**, which routes the signal towards an RF-output port **54**. The first switch **20** alternates between transmitting the filtered signal to the amplifier path **28** or the bypass path **30**. A second switch **43** in the bypass path is included which connects the circulator **55** to ground through a resistor **45** in a first mode,

and connects the circulator **55** to the bypass path **30** in a second mode. The resistor **45** may have a value of **50** ohms, for example.

Any feedback or return signal from the RF-output port **54** is routed to ground when the second switch **43** is in the second mode. When in the first mode switch **20** transmits the signal to the bypass path **30**, switch **43** transmits the signal from the bypass path **30** to the circulator **55**. The circulator **55** routes the signal to the output of the power amplifier, which appears to be a large impedance and reflects most of the signal back to the circulator **55**. The signal is then routed toward the RF-output port **54**. Accordingly, the switch **43** adds isolation due to the fact that the signal cannot be switched to an attenuation path. This embodiment is applicable when only one gain step is desired.

The previous description of the preferred embodiments is provided to enable any person skilled in the art to make or use the present invention. Various modifications to the embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without the use of the inventive faculty. Thus, the present invention is not intended to be limited to the embodiments shown herein, but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

WHAT IS CLAIMED IS:

CLAIMS

1. A power amplifier circuit arrangement, comprising:

a power amplifier having an input and an output;

an RF-input port;

an RF-output port;

means for bypassing the power amplifier through a bypass network;

first means for switching an RF-signal from the RF-input port between the bypass network and the input to the amplifier; and

a circulator connecting the bypass network, the output of the power amplifier, and the RF-output port, whereby the RF-signal inputted from the bypass network to the circulator is routed to the output of the power amplifier and the RF-signal inputted into the circulator from the power amplifier output is routed to the RF-output port.

2. The power amplifier circuit of claim 1 wherein when the power amplifier is powered off, the first means for switching switches the RF-signal to the bypass network such that the RF-signal bypasses the power amplifier, routes through the circulator towards the power amplifier output, is reflected by the power amplifier, and routes through the circulator to the RF-output port.

3. The power amplifier circuit of claim 1 wherein the bypass network comprises a bypass path and an attenuated path and second means for switching between the bypass path and the attenuated path.

4. The power amplifier circuit of claim 3 wherein the attenuated path includes an external resistor connected to ground to allow flexibility in providing gain steps.

5. The power amplifier circuit of claim 3 wherein when the power amplifier is powered off and the first means for switching connects the RF-input port to the bypass network, and when the first means for switching switches to the bypass path, the RF-signal passes through the bypass path, routes through the circulator toward the output of the power amplifier, is reflected by the power amplifier and routes through the circulator to the RF-output port.

6. The power amplifier circuit of claim 3 wherein when the power amplifier is powered off and the first means for switching connects the RF-input port to the bypass network, and when the second means for switching switches to the attenuated path, the RF-signal passes through the attenuated path, routes through the circulator toward the power amplifier output, is reflected by the power amplifier and routes through the circulator to the RF-output port.

7. The power amplifier circuit of claim 4, wherein when the power amplifier is powered on, and the first means for switching connects the RF-input port to the input of the power amplifier, the second means for switching switches the attenuated path to the circulator to maximize reverse isolation and protect against oscillation.

8. The power amplifier circuit of claim 4, wherein the external resistor is a variable resister for gain adjustment.

9. In a power amplifier circuit with an RF-input port and an RF-output port, a bypass network, a circulator connected to the bypass network, the output of the power amplifier, and the RF-output, a method to maximize dynamic range comprising the steps of:

powering off the power amplifier;

switching an RF-signal from the RF-input port to the bypass network;

routing the RF-signal from the bypass path toward the power amplifier through the circulator;

reflecting a substantial portion of the RF-signal incident to the power amplifier output back to the circulator;

routing the reflected RF-signal through the circulator to the RF-output port.

10. A power amplifier circuit arrangement, comprising:

a driver amplifier for transmitting an RF analog signal;

first means for switching said RF analog signal between a bypass path and an amplifier path;

a band pass filter positioned in said amplifier path which filters said RF analog signal and produces a filtered signal;

a power amplifier positioned in said amplifier path which amplifies said filtered signal to produce an amplified signal;

a circulator which routes said amplified signal to an RF-output port;

said bypass path connecting an output of said driver amplifier to said circulator when said first means for switching

switches to said bypass path, wherein said bypass path connects to said circulator such that said RF analog signal input to said circulator from said bypass path is routed to said power amplifier;

second means for switching positioned in said bypass path and switching a connection to said circulator between said bypass path and ground through a resistor, whereby, when said second means for switching connects to ground, power returned to the circuit from the direction of the RF-output port is routed to ground to isolate said power amplifier circuit arrangement.

11. A power amplifier circuit arrangement, comprising:

a driver amplifier for transmitting an RF analog signal;

a band pass filter positioned for filtering said RF analog signal and produces a filtered signal;

first means for switching said filtered signal between a bypass path and an amplifier path;

a power amplifier positioned in said amplifier path which amplifies said filtered signal to produce an amplified signal;

a circulator which routes said amplified signal to an RF-output port;

said bypass path connecting an output of said band pass filter to said circulator when said first means for switching switches to said bypass path, wherein said bypass path connects to said circulator such that said filtered signal input to said circulator from said bypass path is routed to said power amplifier;

second means for switching positioned in said bypass path and switching a connection to said circulator between said bypass path and ground through a resistor, whereby, when said second means for switching connects to ground, power returned to the circuit from the direction of the RF-output port is routed to ground to isolate said power amplifier circuit arrangement.

12. The power amplifier circuit arrangement of claim 11, further comprising means for controlling said first and said means for switching.

13. The power amplifier circuit arrangement of claim 11, wherein said resister is approximately 50 ohms.

14. The power amplifier circuit arrangement of claim 10, wherein said first means for switching switches to said bypass path the power amplifier is turned off.

15. The power amplifier circuit arrangement of claim 11, wherein said first means for switching switches to said bypass path the power amplifier is turned off.

16. A power amplifier circuit arrangement, comprising:

a driver amplifier for transmitting an analog signal;

a first switch for selectively switching the analog signal between a bypass path and an amplifier path, said amplifier path comprising:

a band-pass filter for filtering the analog signal and for producing a filtered signal;

a power amplifier for receiving the filtered signal and for producing an amplified signal;

a first hybrid circuit for splitting the amplified signal into an in-phase signal and a quadrature signal; and

a second hybrid circuit for inverting the in-phase signal to produce an inverted signal and for summing the inverted signal and the quadrature signal to produce a summed signal,

said bypass path connecting an output of said driver amplifier with an isolated port of said second hybrid circuit when said first switch switches the analog signal to said bypass path, whereby the analog signal transmitted from said driver amplifier will reflect off of said power amplifier and be routed to an output port.

17. The circuit arrangement of claim 1, further comprising:

a second switch positioned in said bypass path; and

a terminating resistor connected to a pole of said second switch,

said second switch selectively connecting the isolated port of said second hybrid circuit with either said first switch or said terminating resistor.

18. The circuit arrangement of claim 1, wherein the analog signal is a radio-frequency analog signal.

19. The power amplifier circuit arrangement of claim 1, wherein said first switch switches the analog signal to said bypass path when said power amplifier is turned off.

20. A power amplifier circuit arrangement, comprising:

a driver amplifier for transmitting an analog signal;

a first switch for selectively switching the analog signal between a bypass path and an amplifier path, said amplifier path comprising:

a band-pass filter for filtering the analog signal and for producing a filtered signal;

a power amplifier for receiving the filtered signal and for producing an amplified signal;

a first hybrid circuit for splitting the amplified signal into an in-phase signal and a quadrature signal; and

a second hybrid circuit for inverting the quadrature signal to produce an inverted signal and for summing the inverted signal and the in-phase signal to produce a summed signal,

said bypass path connecting an output of said driver amplifier with an isolated port of said second hybrid circuit when said first switch switches the analog signal to said bypass path, whereby the analog signal transmitted from said driver amplifier will reflect off of said power amplifier and be routed to an output port.

21. The circuit arrangement of claim 5, further comprising:

a second switch positioned in said bypass path; and

a terminating resistor connected to a pole of said second switch,

said second switch selectively connecting the isolated port of said second hybrid circuit with either said first switch or said terminating resistor.

22. The circuit arrangement of claim 5, wherein the analog signal is a radio-frequency analog signal.

23. The power amplifier circuit arrangement of claim 5, wherein said first switch switches the analog signal to said bypass path when said power amplifier is turned off.

24. A method for amplifying a signal in a circuit having a driver amplifier, an amplifier path comprising a first switch, a band-pass filter, a power amplifier, a first hybrid circuit and a second hybrid circuit, and a bypass path connecting an isolated

port of the second hybrid circuit to the first switch, said method comprising:

(A) producing a driver signal from the driver amplifier;

(B) selectively switching the driver signal between the amplifier path and the bypass path using the first switch,

wherein when the driver signal is switched in said switching step to the amplifier path, said method further comprises the steps of:

(a) band-pass filtering the driver signal by the band- pass filter to produce a filtered signal;

(b) amplifying the filtered signal by the power amplifier to produce an amplified signal;

(c) splitting the amplified signal into an in-phase signal and a quadrature signal in the first hybrid circuit;

(d) inverting the in-phase signal to produce an inverted signal in the second hybrid circuit; and

(e) summing the inverted signal and the quadrature signal to produce a summed signal in the second hybrid circuit,

and wherein when the driver signal is switched in said switching step to the bypass path, said method further comprises the steps of:

(a) turning off the power amplifier;

(b) transmitting the driver signal to the isolated port of the second hybrid circuit;

(c) reflecting the driver signal off an output of the power amplifier to an output port.

25. The method of claim 9, wherein the circuit further comprises a second switch positioned in the bypass path, said method further comprising:

selectively switching the second switch between connecting the isolated port of the second hybrid circuit to a terminating resistor and connecting the isolated port of the second hybrid circuit to the first switch.

26. The method for amplifying a signal of claim 9, wherein the driver signal is a radio-frequency analog signal.

27. A method for amplifying a signal in a circuit having a driver amplifier, an amplifier path comprising a first switch, a band-pass filter, a power amplifier, a first hybrid circuit and a second hybrid circuit, and a bypass path connecting an isolated port of the second hybrid circuit to the first switch, said method comprising:

(A) producing a driver signal from the driver amplifier;

(B) selectively switching the driver signal between the amplifier path and the bypass path using the first switch,

wherein when the driver signal is switched in said switching step to the amplifier path, said method further comprises the steps of:

(a) band-pass filtering the driver signal by the band- pass filter to produce a filtered signal;

(b) amplifying the filtered signal by the power amplifier to produce an amplified signal;

(c) splitting the amplified signal into an in-phase signal and a quadrature signal in the first hybrid circuit;

(d) inverting the in-phase signal to produce an inverted signal in the second hybrid circuit; and

(e) summing the inverted signal and the quadrature signal to produce a summed signal in the second hybrid circuit,

and wherein when the driver signal is switched in said switching step to the bypass path, said method further comprises the steps of:

(a) turning off the power amplifier;

(b) transmitting the driver signal to the isolated port of the second hybrid circuit;

(c) reflecting the driver signal off an output of the power amplifier to an output port.

28. The method of claim 12, wherein the circuit further comprises a second switch positioned in the bypass path, said method further comprising:

selectively switching the second switch between connecting the isolated port of the second hybrid circuit to a terminating resistor and connecting the isolated port of the second hybrid circuit to the first switch.

29. The method for amplifying a signal of claim 12, wherein the driver signal is a radio-frequency analog signal.

30. A power amplifier circuit arrangement, comprising:

a driver amplifier for transmitting an analog signal;

a first switch for switching the analog signal between a bypass path and an amplifier path, said amplifier path comprising:

a band pass filter which filters the analog signal to produce a filtered signal;

a first hybrid circuit for splitting the filtered signal into an in-phase signal and a quadrature signal;

a first power amplifier for amplifying the in-phase signal to produce a first amplified signal;

a second power amplifier for amplifying the quadrature signal to produce a second amplified signal; and

a second hybrid circuit for inverting the first amplified signal to produce an inverted signal and for summing the inverted signal and the second amplified signal,

said bypass path connecting an output of said driver amplifier and an isolated port of said second hybrid circuit when said first switch switches the analog signal to said bypass path.

31. A power amplifier circuit arrangement, comprising:

a driver amplifier for transmitting an analog signal;

a first switch for switching the analog signal between a bypass path and an amplifier path, said amplifier path comprising:

a band pass filter which filters the analog signal to produce a filtered signal;

a first hybrid circuit for splitting the filtered signal into an in-phase signal and a quadrature signal;

a first power amplifier for amplifying the in-phase signal to produce a first amplified signal;

a second power amplifier for amplifying the quadrature signal to produce a second amplified signal; and

a second hybrid circuit for inverting the second amplified signal to produce an inverted signal and for summing the inverted signal and the first amplified signal,

said bypass path connecting an output of said driver amplifier and an isolated port of said second hybrid circuit when said first switch switches the analog signal to said bypass path.

32. The power amplifier circuit arrangement of claim 15, wherein the analog signal is a radio-frequency analog signal.

33. The power amplifier circuit arrangement of claim 16, wherein the analog signal is a radio-frequency analog signal.

34. The power amplifier circuit arrangement of claim 15, wherein said switch switches to said bypass path when the power amplifier is turned off.

35. The power amplifier circuit arrangement of claim 16, wherein said switch switches to said bypass path when the power amplifier is turned off.

36. The circuit arrangement of claim 15 further comprising:

a second switch positioned in said bypass path; and

a terminating resistor connected to a pole of said second switch,

said second switch selectively connecting the isolated port of said second hybrid circuit with either said first switch or said terminating resistor.

37. The circuit arrangement of claim 16 further comprising:

a second switch positioned in said bypass path; and

a terminating resistor connected to a pole of said second switch,

said second switch selectively connecting the isolated port of said second hybrid circuit with either said first switch or said terminating resistor.

38. The circuit arrangement of claim 15 further comprising:

a first shunt switch positioned between said first power amplifier and said second hybrid circuit; and

a second shunt switch positioned between said second power amplifier and said second hybrid circuit;

said first and second shunt switches being used to shunt the output of said first and second power amplifiers, respectively, when using said bypass path.

39. The circuit arrangement of claim 16 further comprising:

a first shunt switch positioned between said first power amplifier and said second hybrid circuit; and

a second shunt switch positioned between said second power amplifier and said second hybrid circuit;

said first and second shunt switches being used to shunt the output of said first and second power amplifiers, respectively, when using said bypass path.

40. A method for amplifying a signal in a circuit having a driver amplifier, an amplifier path comprising a first switch, a band-pass filter, a first power amplifier, a second power amplifier, a first hybrid circuit and a second hybrid circuit, and a bypass path connecting an isolated port of the second hybrid circuit with the first switch, said method comprising:

(A) producing a driver signal from the driver amplifier;

(B) selectively switching the driver signal between the amplifier path and the bypass path using the first switch,

wherein when the driver signal is switched in said switching step to the amplifier path, said method further comprises:

(a) band-pass filtering the driver signal by the band- pass filter to produce a filtered signal;

(b) splitting the filtered signal in the first hybrid circuit into an in-phase signal and a quadrature signal;

(c) amplifying the in-phase signal by the first power amplifier to produce an amplified in-phase signal;

(d) amplifying the quadrature signal by the second power amplifier to produce an amplified quadrature signal;

(e) inverting the amplified in-phase signal in the second hybrid circuit to produce an inverted signal; and

(f) summing the inverted signal and the amplified quadrature signal in the second hybrid circuit to produce a summed signal,

and wherein when the driver signal is switched in said switching step to the bypass path, said method further comprises:

(a) turning off the first power amplifier and the second power amplifier;

(b) transmitting the driver signal to the isolated port of the second hybrid circuit;

(c) splitting the driver signal into an in-phase signal and a quadrature signal in the second hybrid circuit;

(d) reflecting the in-phase signal off of the first amplifier signal;

(e) reflecting the quadrature signal off of the second power amplifier;

(f) inverting the reflected in-phase signal in the second hybrid circuit to produce an inverted signal;

(g) summing the inverted signal and the quadrature signal in the second hybrid circuit to produce a summed signal; and

(h) outputting the summed signal to an output port.

41. A method for amplifying a signal in a circuit having a driver amplifier, an amplifier path comprising a first switch, a band-pass filter, a first power amplifier, a second power amplifier, a first hybrid circuit and a second hybrid circuit, and a bypass path connecting an isolated port of the second hybrid circuit with the first switch, said method comprising:

(A) producing a driver signal from the driver amplifier;

(B) selectively switching the driver signal between the amplifier path and the bypass path using the first switch,

wherein when the driver signal is switched in said switching step to the amplifier path, said method further comprises:

(a) band-pass filtering the driver signal by the band-pass filter to produce a filtered signal;

(b) splitting the filtered signal in the first hybrid circuit into an in-phase signal and a quadrature signal;

(c) amplifying the in-phase signal by the first power amplifier to produce an amplified in-phase signal;

(d) amplifying the quadrature signal by the second power amplifier to produce an amplified quadrature signal;

(e) inverting the amplified quadrature signal in the second hybrid circuit to produce an inverted signal;

and

(f) summing the inverted signal and the amplified in-phase signal in the second hybrid circuit to produce a summed signal,

and wherein when the driver signal is switched in said switching step to the bypass path, said method further comprises:

(a) turning off the first power amplifier and the second power amplifier;

(b) transmitting the driver signal to the isolated port of the second hybrid circuit;

(c) splitting the driver signal into an in-phase signal and a quadrature signal in the second hybrid circuit;

(d) reflecting the in-phase signal off of the first amplifier signal;

(e) reflecting the quadrature signal off of the second power amplifier;

(f) inverting the reflected quadrature signal in the second hybrid circuit to produce an inverted signal;

(g) summing the inverted signal and the in-phase in the second hybrid circuit to produce a summed signal; and

(h) outputting the summed signal to an output port.

42. The method for amplifying a signal of claim 25 wherein the driver signal is a radio-frequency analog signal.

43. The method for amplifying a signal of claim 26 wherein the driver signal is a radio-frequency analog signal.

44. The method of claim 25 wherein the circuit further comprises a second switch positioned in the bypass path, said method further comprising:

selectively switching the second switch between connecting the isolated port of the second hybrid circuit to a terminating resistor and connecting the isolated port of the second hybrid circuit to the first switch.

45. The method of claim 26 wherein the circuit further comprises a second switch positioned in the bypass path, said method further comprising:

selectively switching the second switch between connecting the isolated port of the second hybrid circuit to a terminating resistor and connecting the isolated port of the second hybrid circuit to the first switch.

46. A mobile communication unit having a power supply, a digital processor, a receiving chain, a transmitting chain, a duplexer, an antenna, and user interfacing means, said mobile communication unit comprising:

a power amplifier circuit arrangement in said transmitting chain, said power amplifier circuit comprising:

a driver amplifier for transmitting an analog signal;

a first switch for selectively switching the analog signal between a bypass path and an amplifier path, said amplifier path comprising:

a band-pass filter for filtering the analog signal and for producing a filtered signal;

a power amplifier for receiving the filtered signal and for producing an amplified signal;

a first hybrid circuit for splitting the amplified signal into an in-phase signal and a quadrature signal; and

a second hybrid circuit for inverting the in-phase signal to produce an inverted signal and for summing the inverted signal and the quadrature signal to produce a summed signal,

said bypass path connecting an output of said driver amplifier with an isolated port of said second hybrid circuit when said first switch switches the analog signal to said bypass path, whereby the analog signal transmitted from said driver amplifier will reflect off of said power amplifier and be routed to an output port.

47. The mobile communication unit of claim 31, wherein said power amplifier circuit arrangement further comprises:

a second switch positioned in said bypass path; and

a terminating resistor connected to a pole of said second switch,

said second switch selectively connecting the isolated port of said second hybrid circuit with either said first switch or said terminating resistor.

48. The mobile communication unit of claim 31, wherein said first switch switches the analog signal to said bypass path when said power amplifier is turned off.

49. A mobile communication unit having a power supply, a digital processor, a receiving chain, a transmitting chain, a duplexer, an antenna, and user interfacing means, said mobile communication unit comprising:

a power amplifier circuit arrangement in said transmitting chain, said power amplifier circuit arrangement comprising:

a driver amplifier for transmitting an analog signal;

a first switch for switching the analog signal between a bypass path and an amplifier path, said amplifier path comprising:

a band pass filter which filters the analog signal to produce a filtered signal;

a first hybrid circuit for splitting the filtered signal into an in-phase signal and a quadrature signal;

a first power amplifier for amplifying the in-phase signal to produce a first amplified signal;

a second power amplifier for amplifying the quadrature signal to produce a second amplified signal; and

a second hybrid circuit for inverting the first amplified signal to produce an inverted signal and for summing the inverted signal and the second amplified signal,

said bypass path connecting an output of said driver amplifier and an isolated port of said second hybrid circuit when said first switch switches the analog signal to said bypass path.

50. The mobile communication unit of claim 34, wherein said power amplifier circuit arrangement further comprises:

a second switch positioned in said bypass path; and

a terminating resistor connected to a pole of said second switch;

said second switch selectively connecting the isolated port of said second hybrid circuit with either said first switch or said terminating resistor.

51. The mobile communication unit of claim 34, wherein said power amplifier circuit arrangement further comprises:

a first shunt switch positioned between said first power amplifier and said second hybrid; and

a second shunt switch positioned between said second power amplifier and said second hybrid circuit;

said first and second shunt switches being used to shunt the output of said first and second power amplifiers, respectively, when using said bypass path.

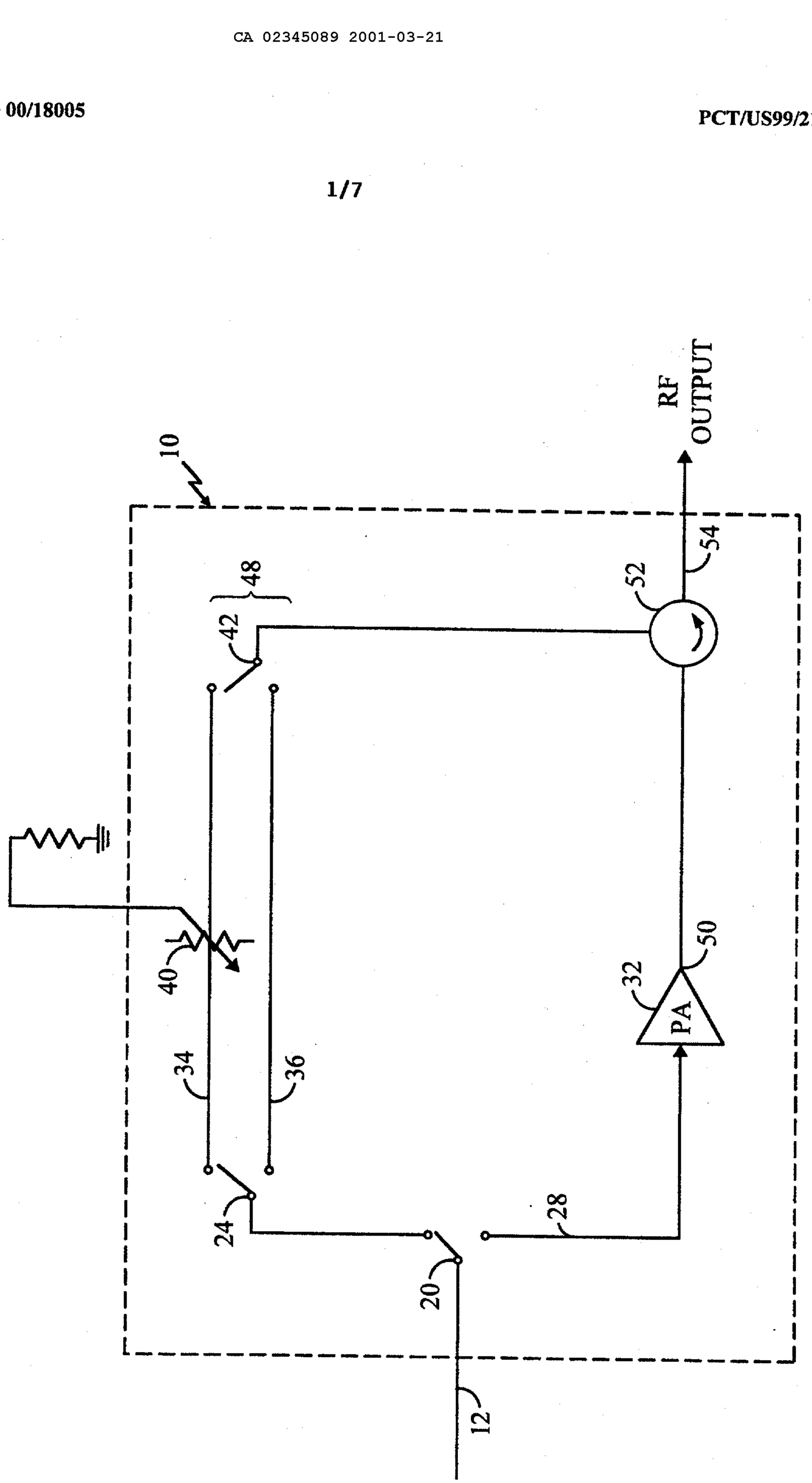


FIG. 1

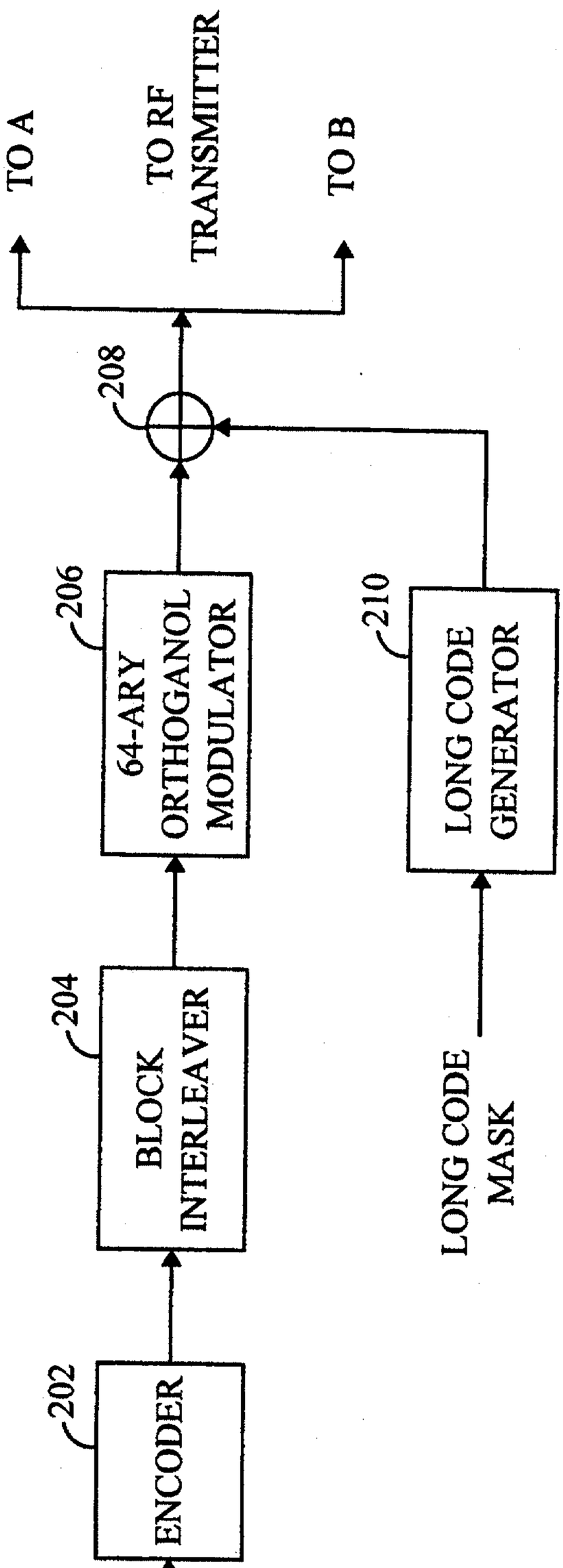
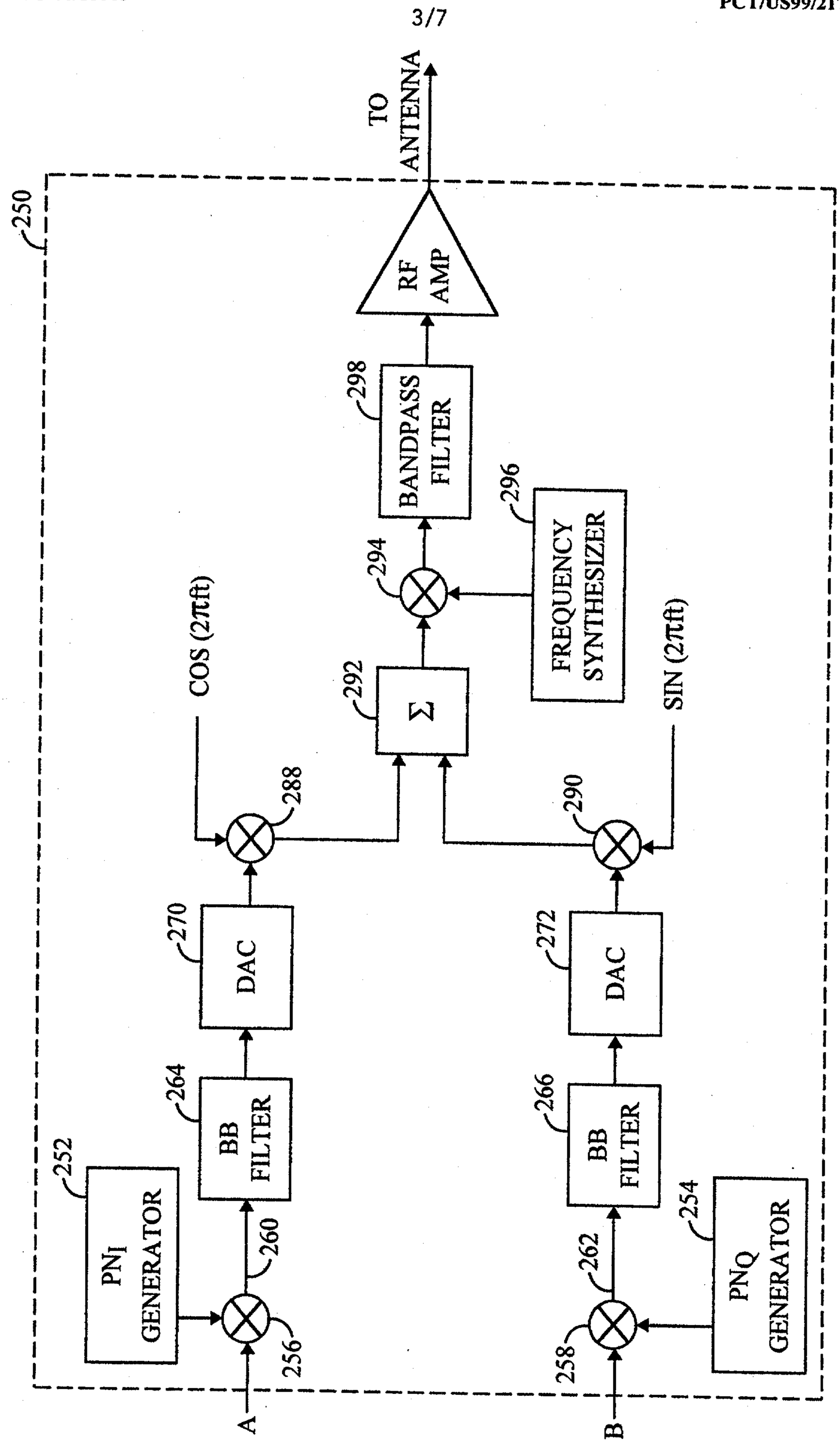

CHANNEL DATA
200
ENCODER
202
BLOCK INTERLEAVER
204
64-ARY ORTHOGANOL MODULATOR
206
LONG CODE GENERATOR
210
LONG CODE MASK
208
TO RF TRANSMITTER
TO A
TO B

FIG. 2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RF AMP
298
BANDPASS FILTER
296
FREQUENCY SYNTHESIZER
294
292
Σ
COS (2πft)
SIN (2πft)
288
290
270
DAC
272
DAC
264
BB FILTER
266
BB FILTER
252
PNI GENERATOR
254
PNQ GENERATOR
260
262
256
258
A
B

FIG. 3

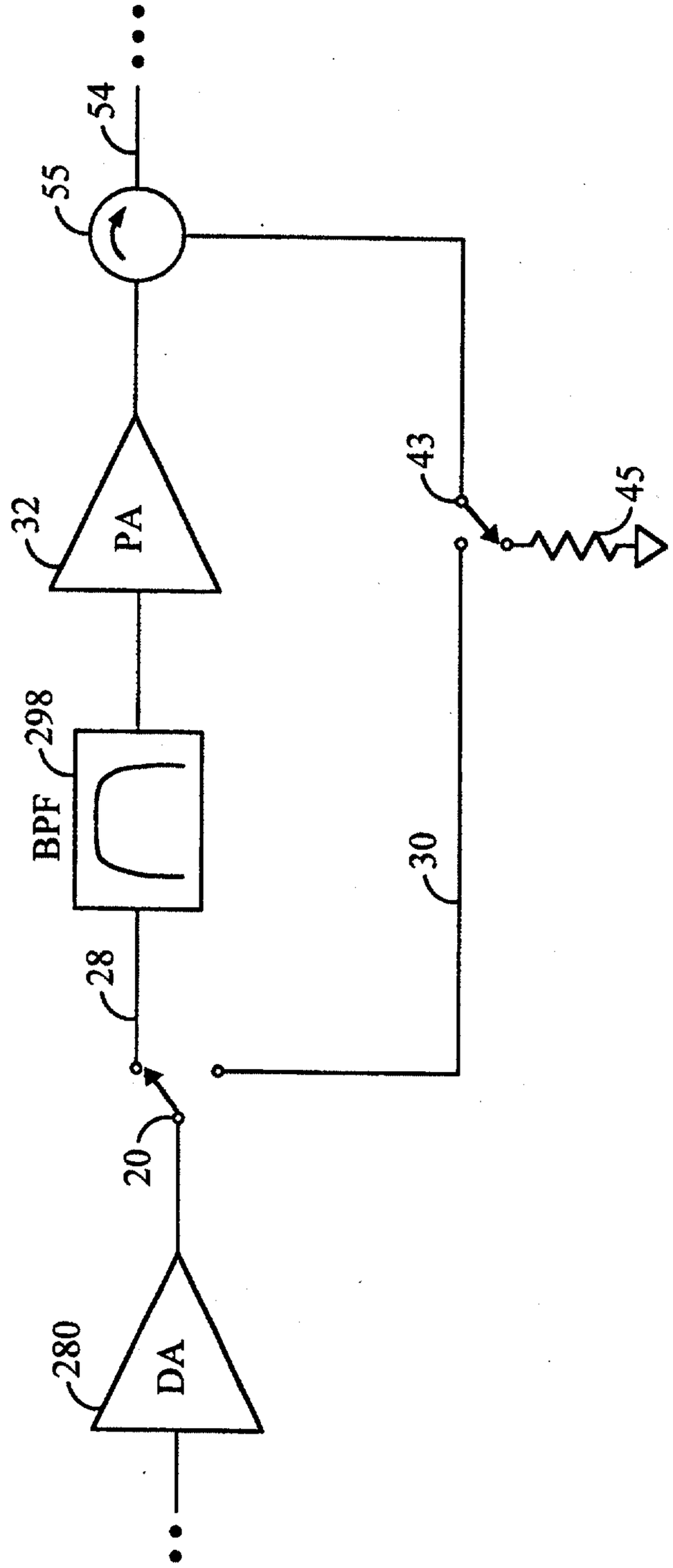


FIG. 4

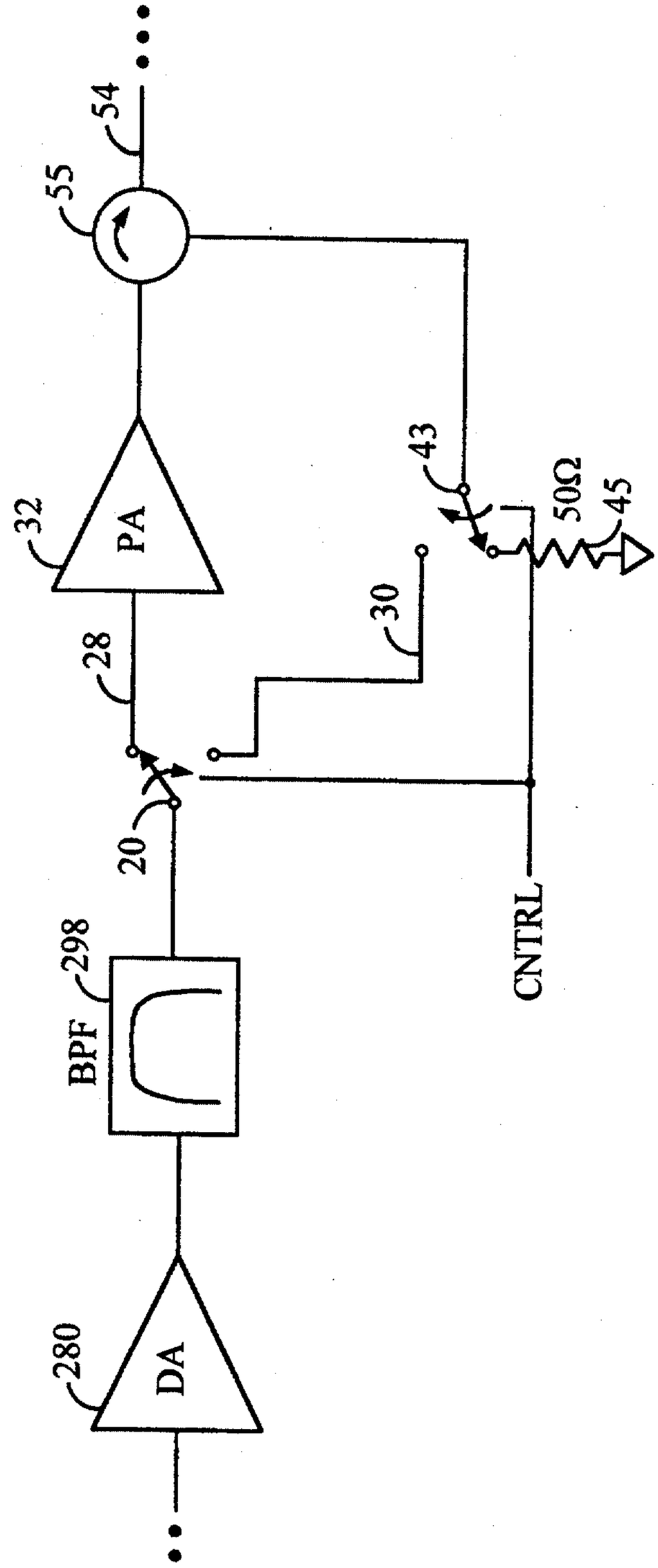
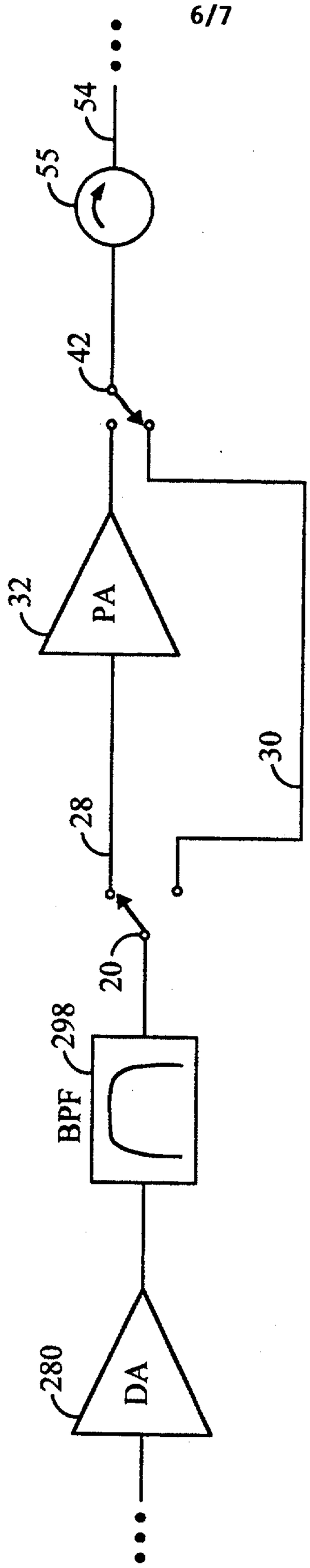
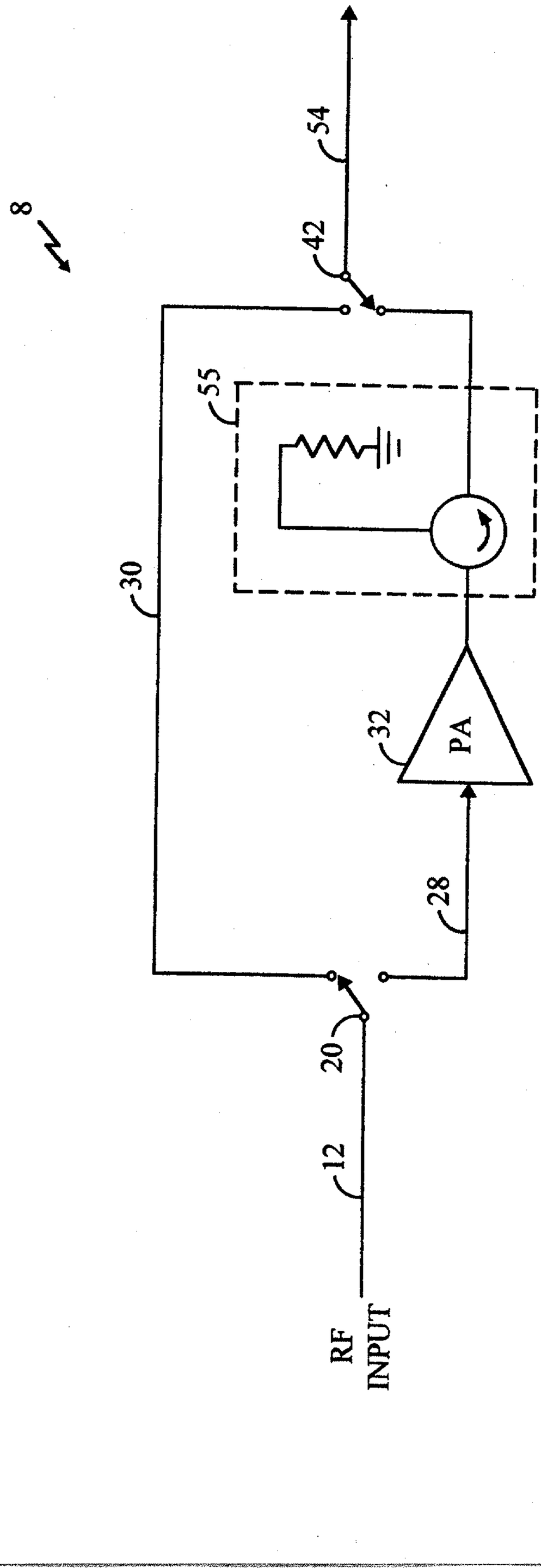


FIG. 5



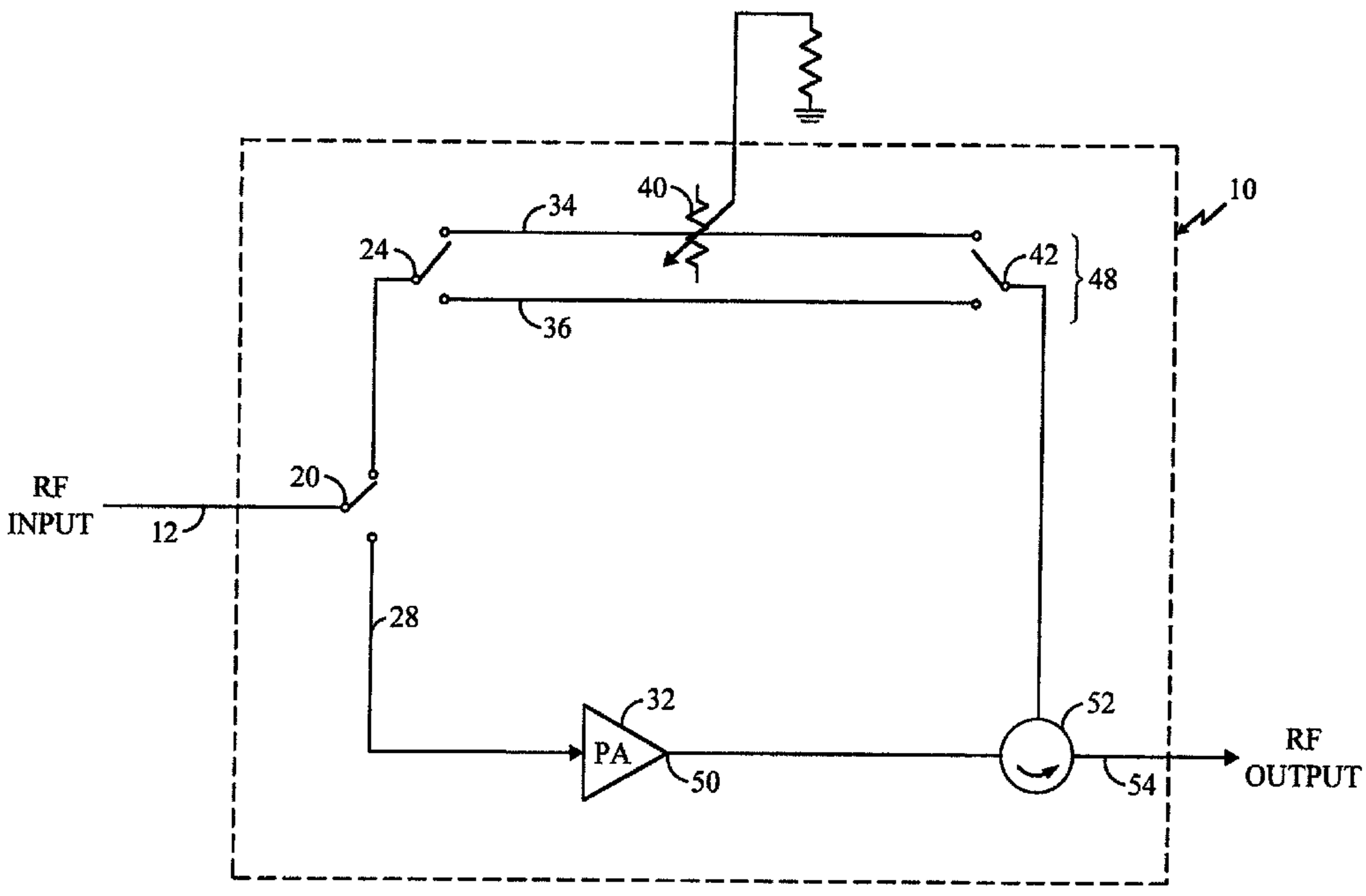
(PRIOR ART)

FIG. 6



(PRIOR ART)

FIG. 7


10
40
34
24
42
48
36
RF
INPUT
12
20
28
32
PA
50
52
54
RF
OUTPUT